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CHRONIC PYELONEPHRITIS AT AUTOPSY

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A thesis presented to the faculty of the
Yale University School of Medicine
in partial fulfillment of the
requirements for the Degree of
Doctor of Medicine

Department of Internal Medicine

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To Frank

ACKNOWLEDGMENT

I wish to express my gratitude to Dr. Lawrence R. Freedman for his kind guidance, encouragement and patience in the preparation of this thesis.

I am also indebted to Dr. Averill A. Liebow for his permission to study the pathological protocols and microscopic slides.

Furthermore I wish to acknowledge the kind help of Mrs. Jeanette Gardner and Mrs. Leah West in obtaining clinical records for me.

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INTRODUCTION

It is generally agreed that clinical pyelonephritis in the absence of obstruction of the urinary tract is primarily a disease of women (2, 33, 32, 17, 10, 14).

A review of published cases, however, shows that there has not been adequate documentation of this. The reported series suffer from one or more of the following defects: a) obstructive disease of the urinary tract was not excluded, b) bacteriologic evidence was derived from broth cultures of urine, a procedure now known to be inadequate for the diagnosis of urinary tract infection, and c) many series do not distinguish the sexes or consider only women.

In a recent study[11] on the medical service of the Grace New Haven Community Hospital where cases were selected on the basis of quantitative urine bacteriology, clinical urinary tract infection in the absence of obstruction was ten times more frequent in women than in men thus documenting the prior noted impressions of most authors.

Chronic pyelonephritis is considered by most authors to result from bacterial infection of the kidney (22, 42, 3, 17). If bacterial infection of the urinary tract is related to chronic pyelonephritis at autopsy, one might expect to find the sex incidence similar in the clinical and autopsy

studies. There is reason to suspect from published data (32, 14) that the sex incidence of chronic pyelonephritis at autopsy in the absence of obstruction differs markedly from the predicted ten to one. If this is indeed the case it would necessitate a re-evaluation of the relationship between clinical urinary tract infection and chronic pyelonephritis at autopsy. The current impressions of chronic pyelonephritis at autopsy are based upon relatively few studies, most of which have not rigidly excluded from consideration cases with obstruction of the genitourinary tract.

The present study was undertaken to examine the sex incidence of chronic pyelonephritis at autopsy, observing the precautions described above. During the course of the study an attempt was made to examine other factors of interest such as hypertension, family history for cardiovascular disease, and renal disfunction as measured by elevation of N.P.N.

METHOD AND MATERIALS

Collection of Data

Of the 1,526 consecutive autopsies* (57.4% males and 42.6% females) at the Grace New Haven Community Hospital over the period from January, 1957 to January, 1959, two groups of cases were selected for further study.

Group I -- All cases with the final pathological diagnosis of chronic pyelonephritis and pyelitis.

Group II**-- All cases diagnosed as "scarred," "markedly scarred," "grossly scarred," and "scarring of the kidneys." Cases diagnosed as "fine scarring of the kidney with Kimmelstiel-Wilson Disease" and "focal scar of the kidney" were not included. There were approximately three cases in the former category and three in the latter. The sex incidence was approximately one to one.

The scarred group (Group II) was included in this study of chronic pyelonephritis so as to avoid the pitfall of individual variation in pathological interpretation and

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* Autopsy numbers 12200 - 13780. (There were 54 cases missing when all slips between 12200 and 13780 were counted. Therefore the series comprises 1,526 cases and not the expected 1,580 cases between numbers 12200 and 13780).

** To be referred to as "scarred kidneys" throughout the rest of this paper.

thus not overlook what others might consider changes compatible with the diagnosis of chronic pyelonephritis.

The autopsy protocols were used at the source of information for the pathological description of the kidneys and genitourinary tract. From the clinical record, the past history of genitourinary disease, diabetes, and hypertension, was obtained, as well as the occurrence of a family history of cardiovascular disease.

Information was collected on urine cultures, i.e., positive and negative and quantitative bacteriology. However, the records of these cultures were for the most part inadequate and only a minority had been quantitatively evaluated. Therefore, the urine culture data is probably not valid in the group considered "positive." Sterile cultures ("negative") are considered valid irrespective of the application of quantitative techniques.

From Group I (chronic pyelonephritis and pyelitis) all cases with evidence of primary genitourinary tract abnormality were eliminated. This consisted of cases with prostatic hypertrophy (including prostatic carcinoma), urethral stricture, extraparenchymal stones (those below the renal parenchyma -- in the calyces, pelves and ureters), carcinomatous obstruction, cystocele and exstrophy of the bladder. The remaining cases of Group I, those without evidence of primary genitourinary tract abnormality, were further studied for evidence of obstruction by looking for

trabeculation of the bladder; no additional cases were found by this technique. Thus a group (Group I A) had been selected for further study which contained all cases of chronic pyelonephritis in the absence of primary genitourinary tract abnormality.

From Group II (scarred kidneys), cases with N.P.N.'s greater than 85 mg. % and/or contracted kidneys (one or both kidneys weighing less than 100 grams, or described in the pathological protocol as "small") were selected. Again, as in Group I (chronic pyelonephritis) cases with evidence of primary genitourinary tract abnormality were excluded from this group of cases with N.P.N.'s greater than 85 mg. % and/or contracted kidney. Thus a group (Group II A) of cases with significant renal disease in the absence of urinary tract obstruction in which the pathological diagnosis of chronic pyelonephritis might have been overlooked, was selected from Group II (scarred kidneys) with N.P.N.'s greater than 85 mg. % and/or contracted kidney.

Groups I A and II A were studied in detail. The frequency of findings such as hypertension, positive and negative urine cultures, diabetes, N.P.N.'s greater than 85 mg. %, past history of urinary tract infection, family history of cardiovascular disease, were correlated for each sex within each group (see Tables 4,8).

Histologic Classification

The microscopic slides of the kidney sections of patients diagnosed pathologically as chronic pyelonephritis, pyelitis and scarred kidney, were reviewed with Dr. Lawrence R. Freedman without prior knowledge of the pathological classifications or sex. They were histologically classified into 6 groups as follows:

1. Non specific scars (N.S.)
2. Minimal focal pyelonephritis (M.F.P.)

   These were kidneys with lesions similar to those described as "typical focal pyelonephritis" present to a lesser degree.
3. Typical focal pyelonephritis (T.F.P.)

   These kidneys had large focal scars, crowding of glomeruli, some of which were hyalinized, dilated and atophic tubules with and without colloid casts, interstitial fibrosis, and infiltration with round cells, separated by areas of normal kidney.
4. Diffuse pyelonephritis-like scarring of the kidney or diffuse scarred end-stage kidney (D.E.K.)

   These kidneys contained most of the elements of the typical chronic pyelonephritis but they were in such an advanced stage of disease that the ability to make this diagnosis with

certainty might be questioned by some investigators.

5. Pyelitis (Pye.)

These kidneys had inflammatory changes limited to the mucous membranes of the pelves.

6. No abnormality seen (No.)

The histological classifications were correlated with the sex in each group.

RESULTS

Group I - Chronic Pyelonephritis and Pyelitis (Table 1)

1,526 consecutive autopsies at the Grace New Haven Community Hospital from January, 1957 to January, 1959 were reviewed. The autopsy group was composed of 57.4% males and 42.6% females. There were 97 cases (6.34% of the total autopsy series) with the pathological diagnosis of chronic pyelonephritis. This group consisted of 63 males (65%) and 34 females (35%). 5 cases (0.33% of total autopsy series) had the pathological diagnosis of pyelitis. Two were males (40%) and three were females (60%). Thus the total group of chronic pyelonephritis and pyelitis (Group I) consisted of 102 cases (6.67% of the total autopsy series), of which there were 65 males (63.7%) and 37 females (36.3%).

From Group I all cases with obstructive disease of the genitourinary tract were excluded. This amounted to 49 cases (48%) of the total chronic pyelonephritis group), of which 40 were males (81.6% of the males of Group I) and 9 were females (18.4% of the females of Group I). Thus it can be seen that many more males are found with primary abnormality of the genitourinary tract in association with pyelonephritis than are females. Prostatic hypertrophy, including carcinoma of the prostate, was the greatest single cause of primary genitourinary tract abnormality. It was

TABLE 1. CHRONIC PYELONEPHRITIS AT AUTOPSY AT G.N.H.C.H. JANUARY, 1957 - JANUARY, 1959

	Total	%	Males	%	Females	%
Total Autopsies	1,526		876	57.4	650	42.6
Chronic Pyelonephritis	97	6.34	63	65.0	34	35.0
Pyelitis	5	0.33	2	40.0	3	60.0
Group I - All cases of Chr. Pyelonephritis and Pyelitis	102	6.67	65	63.7	37	36.3
Chronic Pyelonephritis and Pyelitis with primary G U Tract abnormality	49	48.0	40	81.6	9	18.4
Prostatic Hypertrophy (including ca. prostate)	32	65.2	32	100		
Urethral Stricture	2	4.0	2	100		
Carcinomatous obstruction	5	10.0	2	40.0	3	60.0
Aberrant Renal Art. causing ureteropelvic obstruction	1	2.20			1	100
Stricture Vesical Neck	1	2.20			1	100
Calculi (extraparenchymal)	6	12.10	3	50.0	3	50.0
Cystocele	1	2.20			1	100
Exstrophy of Bladder	1	2.20	1	100		
Group I A - Chronic Pyelonephritis in the absence of primary G U Tract abnormality	53	52.0	25	47.2	28	52.8

found in 32 cases comprising 65.2% of the cases with primary genitourinary tract abnormality. Extraparenchymal caluli (those calculi below the renal parenchyma - in the calyces, pelves, and ureters) was the next largest group. There were 6 cases (12.1%), composed of three males and three females. Third in order of frequency was carcinomatous obstruction of the urinary tract which was found in 5 cases (10%). Two were in females, three in males. Fourth in order of frequency was urethral stricture of which there were two cases (4%) both in males. The remaining factors were each found in one case: stricture of the vesical neck, aberrant renal artery causing ureteropelvic obstruction, and cystocele, which were all found in females, and exstrophy of the bladder found in a male.

Group I A - Chronic Pyelonephritis in the Absence of Primary Genitourinary Tract Abnormality (Tables 2, 3)

There were 53 cases of chronic pyelonephritis in the absence of primary genitourinary tract abnormality. This was 52% of the total number of cases of chronic pyelonephritis diagnosed at autopsy at the Grace New Haven Community Hospital from January, 1957 to January, 1959. Of these there were 25 males (47.2%) and 28 females (52.8%). Applying the Chi square formula to this group, one finds no significant difference between the ratio of males to females at the 5% level. Furthermore if one assumes that the male to female distribution in

TABLE 2. GROUP IA CHRONIC PYELONEPHRITIS IN THE ABSENCE OF GENITOURINARY TRACT ABNORMALITY IN MALES

Male Autopsy #	Age Race	a. P.H. ↑BP	b. BP	c. Fam. Hist. ↑BP	Heart CVA	d. NPN	e. P.H. UTI	f. Urine Cult	g. Diab.	h. Kid Wt.	i. Micro
12323	78 W				X	164		pos.		160 275	TFP
12342	6 W			not obt.						70 75	
12383	68 W		188/102	X	X			pos.		150* 160	TFP
12643	80 W		140/80	not obt.		90		pos.		220 180	TFP
12806	42 N		145/70	X		43		pos.		180 180	TFP
12841	69 N			not obt.		63				140 120	TFP
13011	63 W	X	120/80	not obt.		120		ng.	X	?	TFP
13280	56 W				X	39				110 115	TFP
13315	76 W			neg. f.h.		102				165 145	MFP
13341	67 W			not obt.						160 150	MFP

* a., b., c., d., e., f., g., h., i., -- see Appendix.

(continued on next page)

TABLE 2. GROUP I A CHRONIC PYELONEPHRITIS IN THE ABSENCE OF GENITOURINARY TRACT ABNORMALITY IN MALES (continued)

Male Autopsy #	Age Race	a. P.H. ↑BP	b. BP	c. Fam.Hist. ↑BP	Heart CVA	d. NPN	e. P.H. UTI	f. Urine Cult	g. Diab.	h. Kid Wt.	i. Micro
13534	76 W		80/60	neg.	f.h.	83				110 110	TFP
13559	33 W		140/85	not obt.		70		ng.	X	120 120	DEK
13566	38 N	X	240/130	X		303				70 70	TFP
12422	10 W	X		neg.	f.h.	350		pos.		75 80	DEK
12259	33 N	X	210/140	X		221		ng.		80 75	TFP
12374	66 W		108/70	not obt.		110					DEK
12957	16 N	X	230/170	neg.	f.h.	135		ng.		100 75	DEK
13209	78 N		150/100	neg	f.h.	300				170 190	TFP
13329	57 W			not obt.						160 155	Pye

* a., b., c., d., e., f., g., h., i., -- see Appendix.

(continued on next page)

TABLE 2. GROUP I A CHRONIC PYELONEPHRITIS IN THE ABSENCE OF GENITOURINARY TRACT ABNORMALITY IN MALES (continued)

Male Autopsy #	Age Race	a. P.H. ↑BP	b. BP	Fam. Hist.[c.] ↑BP	Heart CVA	d. NPN	e. P.H. UTI	f. Urine Cult	g. Diab.	h. Kid Wt.	i. Micro
12435	93 W			neg.	f.h.	72				60 90	TFP
12546	66 W									170 140	TFP
12552	38 N			X		55				200 200	TFP
13161	24 W	X				215			X	190 180	DEK
13508	43 W		150/90		X					125 180	TFP
13647	53 W									130 170	MFP

* a., b., c., d., e., f., g., h., i., -- see Appendix.

TABLE 3. GROUP IA CHRONIC PYELONEPHRITIS IN THE ABSENCE OF GENITOURINARY TRACT ABNORMALITY IN FEMALES

Female Autopsy #	Age Race	a. P.H. ↑B.P.	b. B.P.	c. Fam. Hist. ↑B.P.	c. Heart CVA	d. NPN	e. P.H. UTI	f. Urine Cult.	g. Diab.	h. Kid Wt.	i. Micro
12279	50 W		140/70	X		47	X		X	185 175	DEK
12498	71 W		220/110		X	30		pos.		135 130	TFP
12793	40 W				X	43	X	pos.		130 200	TFP
12829	58 W	X	190/110		X	147		pos.			DEK
13003	50 W	X	170/105	neg. f.h.		222	X	pos.		50 50	DEK
13058	64 W	X	200/100		X	210	X	pos.		95 105 *	DEK
13102	63 W	X	180/110	neg. f.h.		92	X	pos.	X	90 85	TFP
13116	84 W		160/90	not obt.		60		pos.	X	170 150	DEK
13255	74 W		110/60	not obt.		127		pos.		comb. 120	DEK
13395	66 W		160/85	neg. f.h.		53		ng.		230 220	NS

* a., b., c., d., e., f., g., h., i., -- see Appendix

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TABLE 3. GROUP IA CHRONIC PYELONEPHRITIS IN THE ABSENCE OF GENITOURINARY TRACT ABNORMALITY IN FEMALES (continued)

Female Autopsy #	Age Race	a. P.H. ↑B.P.	b. B.P.	c. Fam. Hist. ↑B.P.	c. Fam. Hist. Heart	c. Fam. Hist. CVA	d. NPN	e. P.H. UTI	f. Urine Cult.	g. Diab.	h. Kid Wt.	i. Micro
12265	74 W	X	220/90	neg.	f.h.		44			X	135 130 *	MFP
12665	66 W		120/60	X			34	X	pos.		130 135	TFP
12703	74 W		108/70	not obt.			26				110 110	MFP
12872	77 W		202/100	neg.	f.h.		53		pos.		85 85	TFP
12940	57 W		130/60	not obt.			64		pos.	X	220 160	TFP
13127	76 W		160/100	X		X	75				85 105 *	TFP
13275	77 N	X	130/80	not obt.			25		pos.		120 110	TFP
13353	65 W	X	160/70			X	30				250 205	TFP
12709	69 W	X	170/90	not obt.			54	X	pos.		125 185	Pye
12255	71 N	X	220/120			X	186	X	pos.		75 78	TFP

* a., b., c., d., e., f., g., h., i., -- see Appendix

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TABLE 3. GROUP I A CHRONIC PYELONEPHRITIS IN THE ABSENCE OF GENITOURINARY TRACT ABNORMALITY IN FEMALES (continued)

Female Autopsy #	Age Race	a. P.H. ↑B.P.	b. B.P.	c. Fam. Hist. ↑B.P.	c. Heart CVA	d. NPN	e. P.H. UTI	f. Urine Cult.	g. Diab.	h. Kid. Wt.	i. Micro
12206	60 W				X					140 160	Pye
13249	88 W	X	110/70		X	41			X	110 110	Pye
13215	70 W			not obt.						250 5	TFP
13148	72 W		140/70	not obt.		237		pos.		no wt. 1/3 N	
13325	69 W	X					X	pos.	X	110 110	TFP
13380	73 W	X	210/130		X	57		pos.		200 180	TFP
13425	62 W		110/70	not obt.		38				160 140	NS
13466	86 W									30 55	TFP

* a., b., c., d., e., f., g., h., i., -- see Appendix

the general population is 50:50, one finds no significant difference between the autopsy population and that of the general population at the 5% level.

The frequency of the following factors was studied in the males and females with chronic pyelonephritis in the absence of primary genitourinary tract abnormality (Table 4). Hypertention, family history of hypertension, heart disease or cerebrovascular disease, past history of diabetes, finding of positive and negative urine cultures, N.P.N.'s greater than 85 mg. %, presence of contracted kidney (those weighing 100 grams or less, or being described as "small" at autopsy), past history of urinary tract infection, and history of catheterizations and pregnancies.

Hypertension

Of 25 males, 6 had a past history of hypertension and two additional cases had diastolic pressures greater than 100 mm. Hg. on their last hospital admission with no past history of hypertension noted in the chart. Thus 8 men, or 57% of the 14 men on whom blood pressure information was obtained, had hypertension.

Of 28 females, 12 had a past history of hypertension and three had diastolic pressures greater than 100 mm. Hg. on their last hospital admission, with no past history of hypertension noted in the clinical chart. Thus 15 women, or 62.5% of the 24 women on whom blood pressure information

TABLE 4. CLINICAL AND PATHOLOGICAL CORRELATES IN CHRONIC PYELONEPHRITIS IN THE ABSENCE OF OBSTRUCTION (I A)

	Males	%	Females	%
Total	25		28	
P.H. ↑B.P.[a.]	8 of 14	57.1	15 of 24	62.5
Fam. Hist.[c.]				
Negative	6 of 14	42.8	5 of 17	29.2
↑ BP	5 of 14	38.4	3 of 17	17.6
CVA Heart	4 of 14	28.3	10 of 17	58.8
Diab.[g.]	3 of 25	12.0	7 of 28	25.0
Urine Cult.[f.]				
Positive	5 of 9	55.5	17 of 18	94.5
Negative	4 of 9	44.5	1 of 18	5.5
N.P.N. greater 85 mg. %[d.]	11 of 18	63.4	7 of 24	29.1
Contracted kidney	6 of 23	26.1	11 of 27	40.8
P.H. U.T.I.[e.]	0 of 25	0	9 of 28	32.2

HISTOLOGIC CLASSIFICATION[i.]

	Males	%	Females	%
N.S.	0 of 24	0	2 of 27	7.41
M.F.P.	3 of 24	12.5	2 of 27	7.41
T.F.P.	15 of 24	63.0	14 of 27	51.9
D.E.K.	5 of 24	20.4	6 of 27	22.2
Pye.	1 of 24	4.1	3 of 27	11.1
No.	0 of 24	0	0 of 27	0

* a., c., d., e., f.,g., i., -- see Appendix

was obtained, had hypertension.

Family History of Hypertension, Heart Disease, or Cerebrovascular Disease

Of the 14 males from whom a family history was obtained, 6 (42.8%) had a negative family history of hypertension, heart disease, or cerebrovascular disease. 5 (38%) had a positive family history of hypertension; and 4 (28%) had a positive family history of heart disease or cerebrovascular disease. Thus 66.7% had a positive family history for cardiovascular disease.

Of the 17 females from whom a family history was obtained, 5 (29%) had a negative family history for hypertension, heart disease, or cerebrovascular disease; 3 (18%) had a positive family history of hypertension; and 10 (59%) had a positive family history of heart disease or cerebrovascular disease. Thus 77% of women had a positive family history for cardiovascular disease.

Diabetes

Of the 25 males, there were 3 cases of diabetes (12%) and of the 28 females there were 7 cases (25%).

Urine Cultures: Positive or Negative

Of the 9 males who had urine cultures done, 5 (55%) were positive and 4 (44%) were negative.

Of the 17 women who had urine cultures, 16 (94%) were

positive and one (6%) was negative. These positive cultures were difficult to evaluate since quantitative studies were performed on only a few. The negative cultures, however, are considered to have been properly obtained.

N.P.N. Greater than 85 mg. %

Of the 18 men who had N.P.N. reported, 11 (63.4%) had N.P.N. greater than 85 mg. %; and of the 24 women on whom N.P.N.'s were recorded, 7 (29%) were greater than 85 mg. %.

Presence of Contracted Kidney

Of the 23 men on whom kidney size and weight were obtained, 6 (26%) had contracted kidneys (one or both kidneys weighing 100 grams or less, or described in the pathological protocol as "small").

Of the 27 women on whom information on kidney size and weight were obtained, 10 (37%) had contracted kidneys.

Past History of Urinary Tract Infection

Of the 25 males, there was no record of the diagnosis of urinary tract infection ever having been made. However, one male (12259) had "frequency" in 1954 and alpha strept. was obtained on urine culture. This, however, was not quantitatively evaluated. On his last admission the culture was negative. There were several other cases with symptoms which were difficult to evaluate. They are case 12323 -- dysuria and dribbling, 12374 -- frequency and nocturia, and

12259, 13209 -- nocturia, however, the symptoms of these cases were not considered sufficient evidence to state that the patient had a urinary tract infection.

Of the 28 females, there was a history in 9 (32%) of urinary tract infection. One of these, 13102, was diagnosed as cystitis; one, 12665, was diagnosed as "chronic urinary tract disease"; and the remaining 7 were diagnosed as having had pyelonephritis at some time in the past. As in the male group there was one female case with symptoms which were difficult to evaluate, 13275 -- frequency and nocturia.

Catheterization

Information on this is difficult to collect but it appears that of 18 males, 5 males had single catheterizations. One male had an indwelling Foley catheter for an undetermined amount of time. Of 23 women, 12 had single catheterization at one time.

Pregnancy

Of 28 women, there was a history of at least one pregnancy in 11 women. In three cases there were no pregnancies; and in 14 cases there is no mention of the patient having been, or having not been, pregnant.

Pregnancy and Catheterization

Of 28 women, there is a history of 17 women having been pregnant and/or catheterized at some time in the past.

Group II - Scarred Kidneys (Table 5)

Of the 1,526 consecutive autopsies, 66 cases of scarred kidney* (4.3% of the total autopsy series) were found. 39 (59.1%) were male and 27 (40.9%) were female.

In order to examine those cases with significant renal disease in which the pathological diagnosis of chronic pyelonephritis might have been overlooked, scarred kidneys with N.P.N.'s greater than 85 mg. % and/or contracted kidney were selected. There were 26 cases (39.4% of the total scarred group); 14 were men (53.8%) and 12 were women (46.2%); from this group all cases with primary genitourinary tract abnormality were excluded. This amounted to 7 cases (26.9% of the total scarred group), of which 5 were male (71%) and 2 were female (28%). As in the chronic pyelonephritis group, the percent of males with primary genitourinary tract abnormality is much greater than that of females and again, prostatic hypertrophy (including carcinoma of the prostate) was the greatest single factor of primary genitourinary tract abnormality. It was found in 4 cases (51%). Urethral stricture was found in one male and one female and carcinomatous obstruction of the urinary tract was found in one female.

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* Scarred kidney includes all kidneys with the pathological diagnosis of "scarred," "grossly scarred," "markedly scarred," and "scarring of the kidney(s)."

TABLE 5. SCARRED KIDNEYS AT AUTOPSY AT G.N.H.C.H. JANUARY, 1957 - JANUARY, 1959

	Total	%	Male	%	Female	%
Total Autopsies	1,526		876	57.4	650	42.6
Group II - Scarred Kidneys	66	4.3	39	59.1	27	40.9
Scarred kidneys with N.P.N. greater than 85 mg. % and/or contracted kidney	26	39.4	14	53.8	12	46.2
Scarred kidneys with N.P.N. greater than 85 mg. % and/or contracted kidney with primary G U tract abnormalities	7	26.9	5	71.5	2	28.5
Prostatic Hypertrophy (includes carcinoma prostate)	4		4			
Urethral stricture	2		1		1	
Carcinomatous obstruction	1				1	
Group II A - Scarred Kidneys with N.P.N. greater than 85 mg. % and/or contracted kidneys without 1° G-U tract abnormality	19	73.1	9	47.4	10	52.6

Group II A Scarred Kidneys With N.P.N. Greater Than 85 mg. % And/or Contracted Kidney in the Absence of Primary Genitourinary Tract Abnormality (Tables 6, 7)

There were 19 cases of scarred kidney with N.P.N.'s greater than 85 mg. % and/or contracted kidneys, in the absence of primary genitourinary tract abnormality. This was 73.1% of the total number of cases of scarred kidney with N.P.N.'s greater than 85 mg. % and/or contracted kidney. Of these there were 9 males (47%) and 10 females (53%). Applying the Chi square formula to this group (Group II A) one finds no significant difference between the ratio of males to females at the 5% level.

The frequency of the following factors were studied in Group II A (see Table 8). Hypertension, family history of hypertension, heart disease or cerebrovascular disease, past history of diabetes, the finding of positive or negative urine culture, N.P.N.'s greater than 85 mg. %, the presence of contracted kidney and past history of urinary tract infections.

Hypertension

Of the 9 men, there was hypertension in 5 (55%). Of the 10 females, blood pressure information was only obtained in 8. Of these, 6 (75%) had hypertension.

TABLE 6. GROUP II A SCARRED KIDNEYS WITH N.P.N.'s GREATER THAN 85 mg. % AND/OR CONTRACTED KIDNEYS IN THE ABSENCE OF GENITOURINARY TRACT ABNORMALITY IN MALES

Male Autopsy #	Age Race	a. P.H. ↑BP	b. BP	c. Fam. Hist. ↑BP	c. Fam. Hist. Heart CVA	d. NPN	e. P.H. UTI	f. Urine Cult	g. Diab.	h. Kid Wt.	i. Micro
12682	65 W	X	170/110	not obt.		88	X	ng		94 90	DEK
12964	85 W		100/60	not obt.		59				120* 120	MFP
12982	69 W	X	220/140	not obt.		49				30 125	DEK
13037	49 W		160/90	not obt.						80 75	TFP
12920	41 N	X	230/140	not obt.		201		pos.		90 75	TFP
13132	77 W	X	130/80	not obt.		233		ng		comb. 210	DEK
13182	81 W		145/55	not obt.		88				130 155	DEK
12754	76 W		104/80	not obt.		91			X	110 120	NS
12746	82 W	X	140/60	neg. f.h.		118		pos.		150 140	MFP

* a., b., c., d., e., f., g., h., i., -- see Appendix.

TABLE 7. GROUP II A SCARRED KIDNEYS WITH N.P.N.'s GREATER THAN 85 mg. % AND/OR CONTRACTED KIDNEYS IN THE ABSENCE OF GENITOURINARY TRACT ABNORMALITY IN FEMALES

Female Autopsy #	Age Race	a. P.H. ↑ BP	b. BP	c. Fam. Hist. ↑BP	c. Fam. Hist. Heart CVA	d. NPN	e. P.H. UTI	f. Urine Cult.	g. Diab.	h. Kid Wt.	i. Micro
12310	50 W		130/80	neg.	f.h.	27				135 85	TFP
12447	73 W		125/80	neg.	f.h.	32	X	pos.		110* 140	TFP
12728	52 W	X	140/90	not obt.		53	X			10 200	TFP
12649	77 N	X	220/100	neg.	f.h.	106		pos.	X	90 90	NS
13533	92 W				X	116		pos.		comb. 155	NS
13168	75 W	X	170/85	not obt.		32			?	100* 120	MFP
13342	81 W	X	200/90	not obt.						70 130	TFP
12384	40 W			not obt.		104		pos.		230 240	No.
13015	50 W	X	160/90		X	292	X	pos.		125 117	
13166	42 N	X	300/130		X	146	X			100 115	DEK

* a., b., c., d., e., f., g., h., i., -- see Appendix.

TABLE 8. CLINICAL AND PATHOLOGICAL CORRELATES IN SCARRED KIDNEY GROUP II A

	Males	%	Females	%
Total	9		10	
P.H. ↑B.P.[a.]	5 of 9	55.5	6 of 8	75.0
Fam. Hist.[c.]				
Negative	1 of 1	100.	3 of 6	50.0
↑.B.P.	0 of 1	0	0 of 6	0
CVA Heart	0 of 1	0	3 of 6	50.0
Diab.[g.]	1 of 9	11.1	1 of 10	10.0
Urine cult.[f.]				
Positive	2 of 4	50.0	5 of 5	100.
Negative	2 of 4	50.0	0 of 5	0
N.P.N. greater 85 mf.%[d.]	6 of 8	75.0	5 of 9	55.5
Contracted kidney	6 of 9	66.6	8 of 10	80.0
P.H. U.T.I.[e.]	1 of 9	11.1	4 of 10	40.0

HISTOLOGIC CLASSIFICATION[i.]

	Males	%	Females	%
N.S.	1 of 9	11.1	2 of 9	22.2
M.F.P.	2 of 9	22.2	1 of 9	11.1
T.F.P.	2 of 9	22.2	4 of 9	44.5
D.E.K.	4 of 9	44.5	1 of 9	11.1
Pye.	0 of 9	0	0 of 9	0
No.	0 of 9	0	1 of 9	11.1

* a., c., d., e., f., g., i., -- see Appendix.

Family History of Hypertension, Heart Disease, or Cerebrovascular Disease

Only in one of the 9 men was a family history obtained, and it was negative for the above. Of the 10 women, 6 family histories were obtained. Three were negative and three had a positive history for heart disease or cerebrovascular disease.

Diabetes

Of the 9 men, there was a history of diabetes in one (11%) and of the 10 women there was a history of diabetes in one (10%).

Urine Cultures: Positive or Negative

Of the 9 men, 4 had urine cultures. Two were positive and two were negative. Of the 10 women, 5 had urine cultures. All were positive. Once again, the positive cultures are difficult to interpret since quantitative studies were performed on only a few. The negative cultures however are considered to have been properly obtained.

N.P.N.'s Greater than 85 mg. %

Of the 9 men, N.P.N. was recorded in 8. Of these 6 (75%) had N.P.N.'s greater than 85 mg. %. Of the 9 women on whom N.P.N.'s were recorded, 5 (55%) had N.P.N.'s greater than 85 mg. %.

Presence of Contracted Kidneys

Of the 9 men, 5 (55%) had contracted kidneys and of the 10 women, 7 (70%) had contracted kidneys.

Past History of Urinary Tract Infection

Of the 9 men, only one (11%) had a past history of urinary tract infection. Of the 10 women, 4 (40%) had a past history of urinary tract infection.

Many of the figures in this section on Group II A (scarred kidney) comprise very few patients and caution must therefore be exercised in drawing conclusions from them. However, they agree with those obtained earlier in the study on Group I A (chronic pyelonephritis) and it is felt that they tend to confirm the general thesis that the incidence of lesions called chronic pyelonephritis or perhaps due to chronic pyelonephritis (Group II A) is the same in both sexes.

Histologic Classification of Kidney Sections

The slides were reviewed without prior knowledge of the autopsy diagnosis or sex for both the pyelonephritis group and the scarred kidney group. They were histologically classified into 6 groups as follows: Nonspecific Scars, Minimal Focal Pyelonephritis, Typical Focal Pyelonephritis, Diffuse Pyelonephritis-like Scarred End stage Kidney, Pyelitis, No abnormality seen. (See Method for definition of groups).

a. Group I A - Chronic Pyelonephritis in the Absence of Primary Genitourinary Tract Abnormality (Table 4)

Of the 24 men on whom microscopic slides of the kidney were obtained, there were no cases of nonspecific scars of the kidney. There were three (12%) that were placed in the category of minimal focal pyelonephritis. 15 cases (63%) had typical focal pyelonephritis. There were 5 cases (20%) with diffuse end stage pyelonephritis-like kidneys, and one case of pyelitis.

Of the 27 women on whom microscopic slides of the kidney were obtained, there were 2 cases (7%), with non-specific scars of the kidney. There were also 2 cases (7%) with minimal focal pyelonephritis. 14 cases (52%) had typical focal pyelonephritis and 6 cases (22%) had diffuse end stage pyelonephritis-like kidneys. There were three cases in the category of pyelitis. All three cases in the histologic category of pyelitis were in agreement with the cases of pyelitis diagnosed at autopsy. (It will be noted that 5 cases were diagnosed at autopsy and only 4 cases, 3 women and one man, are noted in Group I A, since one man had primary genitourinary tract abnormality and was excluded.)

b. Group II A - Scarred Kidneys with N.P.N.'s Greater Than 85 mg. % and/or Contracted Kidney in the Absence of Primary Genitourinary Tract Abnormality (Table 8)

Of the 9 men, there was one (11%) with nonspecific scars of the kidney. There were two cases (22%) in the

category of minimal focal pyelonephritis, and two cases (22%) in the category of typical focal pyelonephritis. 4 cases (44%) were diffuse end stage pyelonephritis-like kidneys.

Of the 9 females on whom microscopic slides were obtained, there were two cases (22%) of nonspecific scars of the kidney. One case (11%) was in the category of minimal focal pyelonephritis, and 4 cases (44%) were in the category of typical focal pyelonephritis. There was one case of diffuse end stage pyelonephritis-like kidney, and one case (11%) with no apparent pathology. Thus 4 of the 9 scarred males appeared to have either minimal or typical pyelonephritis as did 5 of the 9 scarred females.

It is felt that there were no significant differences between the two sexes in the histological evaluation which was carried out within the pathological groups selected for study.

DISCUSSION

This study has demonstrated that chronic pyelonephritis as seen at autopsy in the absence of obstructive disease of the genitourinary tract occurs with equal frequency in males and females.

In a review of the 1,526 consecutive autopsies at the Grace New Haven Community Hospital from January, 1957 to January, 1959 there were 97 cases with the pathological diagnosis of chronic pyelonephritis. This overall incidence of 6.34% compares favorably with previous surveys reported in the literature.

REFERENCE	FREQUENCY OF CHRONIC PYELONEPHRITIS
Shure (39)	2.5% of 11,898 autopsies
Raaschou (32)	5.6% of 3,607 autopsies
Jackson et al. (15)	9% of 4,425 autopsies
Kinney and Mallory (20)	14% of 1,000 autopsies
Keefer (17)	15-20% of "all autopsies"
Schreiner (37)	20% of random autopsies

In order not to overlook any cases of chronic pyelonephritis this study has also included in a separate group (Group II) those cases in which a pathologic diagnosis of "scarred kidneys" was made. This was done because the etiologic factors causing renal scarring are not always

certain and scarring may be due to chronic pyelonephritis. In the scarred kidney group (Group II) the male to female ratio was found to be approximately one to one. From the scarred kidney group cases with N.P.N.'s greater than 85 mg. % and/or contracted kidneys were selected and analyzed (Group II A), so that one might study those cases with significant renal disease. Again, as in the chronic pyelonephritis group (Group I A), the number of males and females were approximately equal, in the absence of obstructive disease of the genitourinary tract.

In the literature opinions differ as to the sex incidence of chronic pyelonephritis at autopsy (Table 9). This issue is greatly obscured since most of these investigators did not rigidly exclude pyelonephritis in the presence of obstructive disease (14, 1, 39, 19). Therefore, from these studies one can get little idea of the true sex incidence of chronic pyelonephritis in the absence of obstructive disease of the genitourinary tract. Three studies, however, did delineate pyelonephritis in the absence of obstruction. One of these (Likely et al.) is difficult to evaluate since "nonobstructive pyelonephritis" is not defined. The remaining two studies (2, 32) where all of the obstructive disease of the urinary tract is defined and cases with obstruction are excluded, each have the incidence of two females to one male. These results are not dissimilar from those in the present study showing an equal frequency

TABLE 9. CHRONIC PYELONEPHRITIS AT AUTOPSY

Reference	Criteria for Case Selection	Number of Cases		
		Total	Male	Female
Bell (2)	Autopsy Review of 59,064 cases. Cases with obstructive uropathy are eliminated.	22	7	15
Jackson et al. (14)	Autopsy Review of 194 cases. Obstruction not excluded	194	109	85
Barker and Walters (1)	24 cases diagnosed chr. atrophic pyelo. at autopsy. Obstruction not excluded.	24	8	16
Shure (39)	290 cases diagnosed chr. pyelo. at autopsy. Obstruction not excluded.	290	160	130
Likely et al. (21)	22 cases of "non obstructive" chr. pyelo. at autopsy selected from 93 cases that died in uremia (NPN > 90)	22	15	7
Kincaid-Smith et al. (19)	26 cases chr. pyelo. at autopsy selected from 124 cases of malignant hypertension at autopsy. Obstruction not excluded	26	12	14
Raaschou (32)	Autopsy Review of 3,607 cases. Obstruction not excluded.	202	113	89
Raaschou (32)	The same series as above but all obstruction cases excluded.	66	23	43

of males and females with chronic pyelonephritis in the absence of obstruction.

To be certain that there was no histologic pattern typical of one sex, the slides of the present series were reviewed without prior knowledge of the autopsy diagnosis or the sex, for both the chronic pyelonephritis group and the scarred kidney group. The histologic changes seen within the two groups did not differ significantly between the two sexes.

The age incidence of pyelonephritis in males and females was analyzed (see Figures 1 and 2) to see if there was any particular difference between the distribution of ages in the two sexes. The peak distributions were similar but there were proportionately more males in the younger age groups. The difference between these results and others where there was a preponderance of males in the age group over 60 years (28, 39) is most likely due to the inclusion of prostatic hypertrophy in their series, and its exclusion in this series.

The incidence of hypertension (diastolic pressure greater than 100 mm. Hg.) was determined in the groups with chronic pyelonephritis and scarred kidney in the absence of obstruction (Groups I A and II A). In the former, the males and females have a 57.1% and a 62.5% incidence respectively. Similarly in the latter, the incidence of hypertension for males and females was 55.5% and 75% respectively. It is

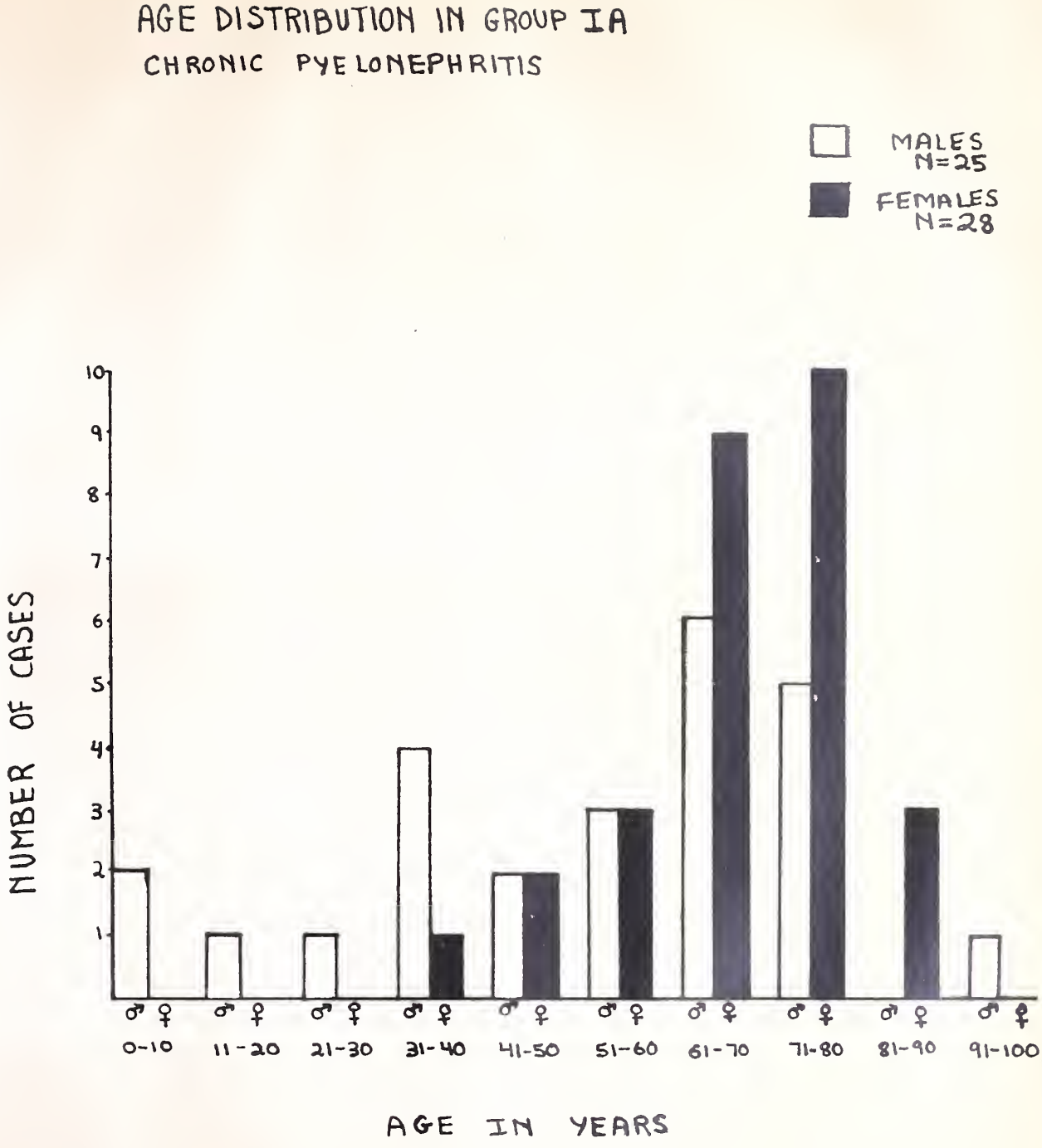
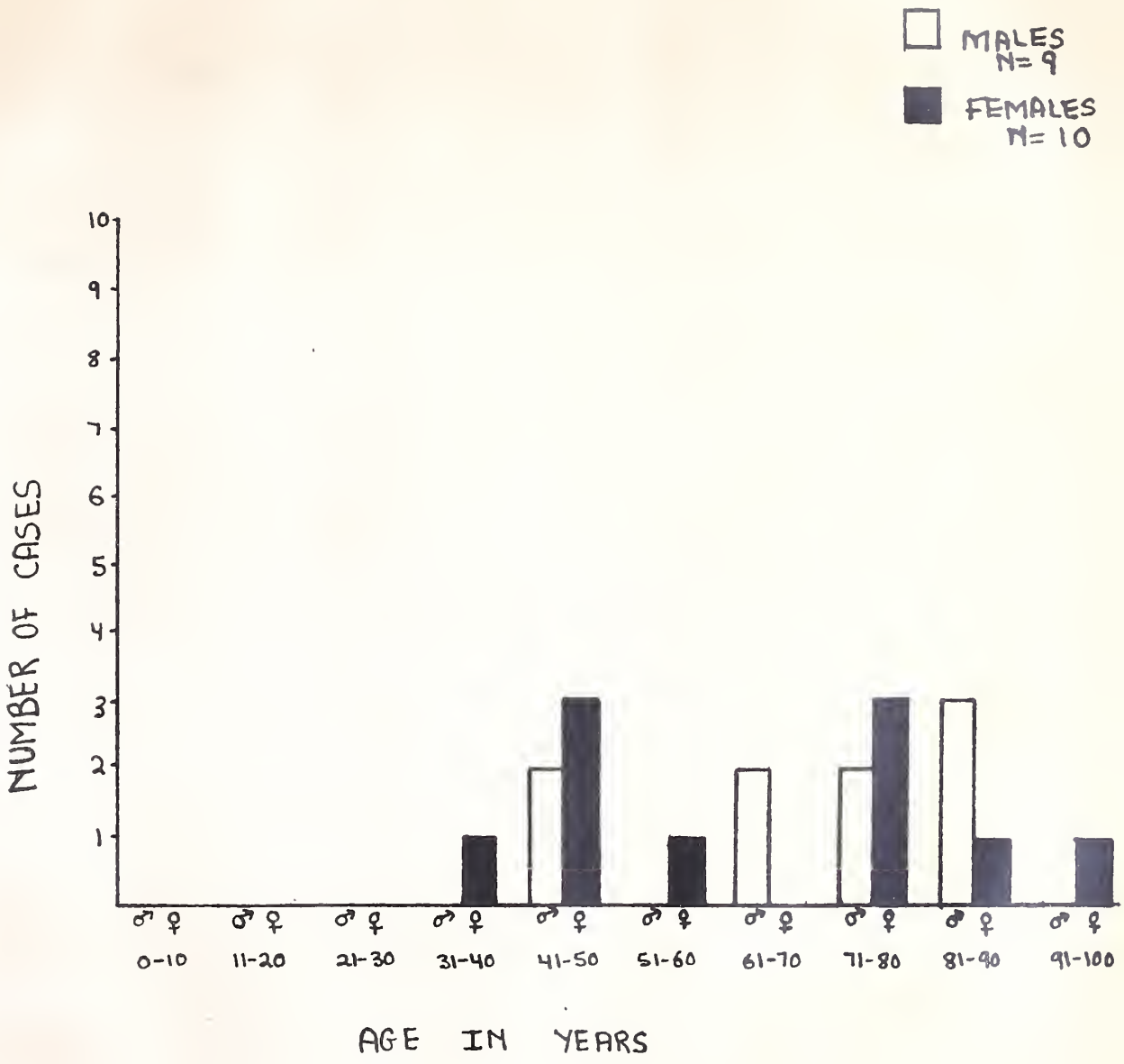

AGE DISTRIBUTION IN GROUP IA
CHRONIC PYELONEPHRITIS
MALES N=25
FEMALES N=28
NUMBER OF CASES
10
9
8
7
6
5
4
3
2
1
♂ ♀
0-10
11-20
21-30
31-40
41-50
51-60
61-70
71-80
81-90
91-100
AGE IN YEARS

FIGURE #1

AGE DISTRIBUTION IN GROUP II A
SCARRED KIDNEYS



FIGURE#2

apparent that the two sexes are approximately equally affected. Since these groups are without matched control patients, nothing definite can be said about the incidence of hypertension in pyelonephritis. However, it is of interest to compare this data with that of others (Table 10).

Since Longcope (21) first described the association between pyelonephritis and hypertension and Weiss and Parker (43) demonstrated the histological lesions in chronic pyelonephritis which were associated with hypertension, many have written on the relationship between the two diseases. Unlike most investigators Bell (2) felt that hypertension is seldom related to "uncomplicated chronic pyelonephritis" and Goldring and Chasis (13) have produced evidence from which they deduce that there is no correlation between the two diseases. However most authors (Table 10) believe that the incidence of hypertension is significantly higher in patients with chronic pyelonephritis than in those without. The evidence in the literature of an increased incidence of hypertension in the presence of pyelonephritis is difficult to evaluate due to the following factors:

1) Not all studies had control groups of the same age distribution as the group of pyelonephritis patients.

2) Some studies were done on clinical cases, others on autopsy cases.

3) The criteria for the diagnosis of clinical pyelonephritis are questionable, or not given.

TABLE 10. HYPERTENSION IN CHRONIC PYELONEPHRITIS

Reference	Criteria for Case Selection	No. cases with Chr. Pyelo	% with ↑B.P.	Control Group No.	% with ↑B.P.
Bell (2)	Autopsy review of 59,064 cases. Cases with obstructive uropathy are eliminated.	20	40%		
Nesbit and Conger (28)	Clinical chr. pyelo. Diagnosis verified in 80% by pyelography or pathological exam. 20% diagnosed by ureteral catheterization. Renal ds. 2° to calculus or hydronephrosis excluded.	172	34%		
Braasch and Jacobson (6)	Clinical chr. pyelo. Diagnosed by history, cystogram, ureteral catheterization with bilateral pyuria, and urogram. Obstruction included	119*	16.8%		9.17%*
		61**	44.3%		37.9%**
		180	26%	975	20%
Barker and Walters (1)	Autopsy diagnosis of 24 cases of atrophic pyelonephritis. Obstruction included.	57	45.6%		
		24a.	62.5%		
Shure (39)	Autopsy Diagnosis of 290 cases chr. pyelonephritis. Obstruction included.	290	44.4%		34.9%
Mansfield et al. (25)	Autopsy diagnosis of healed pyelonephritis	11	63.6%		
Longcope (22)	Clinical chr. pyelonephritis. 22 cases, 9 autopsy verification	11	50%		

a. Kidneys weighing 75 grams or less
* under 50 years old
** over 50 years old

(continued on next page)

TABLE 10. HYPERTENSION IN CHRONIC PYELONEPHRITIS (continued)

Reference	Criteria for Case Selection	No. cases with Chr. Pyelo.	% with ↑ B.P.	Control Group No.	Control Group % with ↑ B.P.
Kincaid-Smith (18)	Autopsy diagnosis of 45 cases of chronic pyelonephritis	45	66%		
Brod (8)	? method of selection	132	59.7%		30%
	with positive F.H. of ↑ B.P. and over 40 years old		84.5%		30%
	younger with no F.H. of ↑ B.P.		43.5%		0
Braasch et al. (7)	Clinical study of 1,684 patients with renal surgery	43	46.5%	975	20%
Weiss and Parker (42)	Clinical study selected cases for series with known arterial hypertension. Therefore, these figures are not valid.	38	68%		
Keefer (17)			20%		

CHRONIC PYELONEPHRITIS IN MALIGANT HYPERTENSION

		No. cases w. malig. ↑ B.P.	% with Pyelo
Saphir and Taylor (36)	Autopsy of 50 patients that died in uremia from malignant hypertension	50	82%
Kincaid-Smith et al. (19)	Autopsy of 124 cases malignant hypertension	124	21%
Weiss and Parker (42)	Autopsy study		15-20%

4) The definition of hypertension is not uniform throughout the literature.

5) In many autopsy studies, investigators have divided chronic pyelonephritis into various forms, e.g., atrophic, nonatrophic, and have only studied the incidence of hypertension in one form or the other and thus have not included all cases of chronic pyelonephritis in their series. It is apparent from this brief review that the relation of pyelonephritis to hypertension remains to be definitely demonstrated.

In the present study 67% of the men and 76% of the women with chronic pyelonephritis in the absence of obstruction (Group I A) had a positive family history of cardiovascular disease. Again one sees that the two sexes are equally affected. The role of heredity in essential hypertension has been discussed at great length. The majority of opinion seems to favor some sort of genetic mechanism in hypertension, though the basis of inheritance is thought to be multifactorial (30, 29, 41, 40).

In the hypertension of chronic pyelonephritis as well as in essential hypertension, genetic factors may be important. Kincaid-Smith et al. (19) and Sowry (40) found a positive family history for hypertension present as frequently in a group of patients with pyelonephritis as in a group of patients with essential hypertension. Brod (8)

found that the incidence of hypertension in patients with pyelonephritis over 40 years old, who had a family history of hypertension, was 84.5%, whereas in a group of pyelonephritic patients where there was no mention of family history the incidence of hypertension was 59.7%, and further that the incidence of hypertension in a nonpyelonephritic control group with a family history of hypertension was 30%. Thus it appears that heredity and perhaps pyelonephritis both have roles in the etiology of hypertension and that inheritance which is believed to be a significant factor in the etiology of essential hypertension is perhaps equally significant in the hypertension of chronic pyelonephritis. It has furthermore been suggested that patients with essential hypertension are more likely to develop chronic pyelonephritis (34, 40). Pertinent to this is the study of Woods (44) which has shown in animals that desoxycorticosterone acetate induced hypertension predisposes to renal infection. The critical control of this study was omitted, however, when the author neglected to test the susceptibility of infection of rats given desoxycorticosterone acetate before they developed hypertension. It can be seen that the exact interrelationship of hypertension, heredity, and pyelonephritis are not yet clearly defined.

Thus this study has demonstrated that chronic pyelonephritis at autopsy in the absence of obstruction has an

equal incidence in men and women and further that there is no histologic pattern typical of one sex or any characteristic age distribution for either sex. Neither is there any difference in the incidence of hypertension or positive family history for cardiovascular disease between men and women.

In contrast to the one to one ratio of males to females at autopsy, the clinical incidence of urinary tract infection heavily favors women. On reviewing the literature (Table 11) very few studies of clinical pyelonephritis in the absence of obstruction have been made. In Raaschou's (32) study of 31 clinical cases of chronic pyelonephritis, there were 14 cases in the absence of obstruction. It appears that of the 14, 13 were female and only one was male. In a recent (11) clinical study of urinary tract infection in the absence of obstruction in all patients treated by the medical service over one and a half years at the Grace New Haven Community Hospital, the female to male ratio was ten to one. The diagnosis of urinary tract infection in this study was based on quantitative methods for evaluating urine bacteriology.

The discrepancy between the ten females to one male clinically and the one female to one male at autopsy requires an explanation. Perhaps the following can in part explain the marked difference of the sex incidence in clinical and pathological pyelonephritis.

TABLE 11. CLINICAL PYELONEPHRITIS

Reference	Criteria for Case Selection	Number Cases Studied		
		Total	Male	Female
Jackson et al. (14)	Series of patients admitted to hospital with pyelonephritis; obstruction not excluded.	79	22	57
Nesbit and Conger (28)	Diagnosis verified in 80% by pyelography or pathalogical exam. 20% diagnosed by ureteral catheterization. Renal disease 2° to calculus or hydronephrosis excluded	172	66	106
Caulk (9)	No criteria given. Obstruction not excluded.	2464	824	1640
Braasch and Jacobson (6)	Bilateral Chr. Pyelonephritis diagnosed by history, cystogram, ureteral catheterization with bilateral pyuria, urogram obstruction not excluded	180	112	68
Longcope (22)	Chr. Pyelonephritis in 22 cases, 9 autopsy verifications. Obstruction not excluded	22	7	15
Loopuyt (23)	Patients admitted to hospital from 1937-1941 for , therapy of urinary tract infection. Obstruction not excluded	186	8	178
Raaschou (32)	31 cases diagnosed by symptoms, urinalysis, kidney function tests, pyelograms, cystoscopy and ureteral catheterization. Obstruction not excluded.	31	10	21
Raaschou (32)	The same series as above - obstruction cases excluded.	14	1	13

1. Urinary tract infection as seen in the clinic bears no etiologic relationship to chronic pyelonephritis at autopsy. This view does not seem likely because:

a) It must be kept in mind that most pyelonephritis at autopsy is found in association with obstruction, a procedure well known to predispose the kidney to infection. The following chart demonstrates the incidence of pyelonephritis in association with obstruction.

Nesbit and Conger (28)	40% of 172 cases had obstruction
Bell (2)	Obstructive chronic pyelonephritis 12 times as common as nonobstructive chronic pyelonephritis
Raaschou (32)	63% of 202 cases had obstruction.
Rhoads (34)	75.5% of 548 cases had obstruction.
Sanjuro (35)	98% of 256 cases had obstruction.

The present study also demonstrates the large number of cases of chronic pyelonephritis that are associated with obstruction of the genitourinary tract. It was found that 48% of 102 cases were associated with obstruction (see Table 1). As obstruction is well known to predispose the kidney to infection, it is highly probable that in a large majority of cases, chronic pyelonephritis at autopsy is on the basis of prior urinary tract infection; and

b) Experimental studies have demonstrated

unequivocably that the histologic characteristics of chronic pyelonephritis in man can be reproduced by bacterial infection of the kidneys in animals (24).

2. Infections in males are more easily overlooked than infections in females. Are there a large number of men who have clinically inapparent urinary tract infection in which case do they have fewer or different symptoms? If this is true, why are there fewer symptoms in men? Is this a different kind of infection or does host response differ? There is no definite evidence on these points but there is no reason to support either of these possibilities. In the present study the finding of N.P.N.'s greater than 85 mg. % in 63% of the men and in 29% of the women certainly suggests that kidney disfunction is at least as severe in men as in women.

Since prostatitis is a common disease even in young men one might ask whether this type of infection might be equivalent to cystitis and posterior urethritis in women. This could bring the clinical incidence of disease in the sexes closer together. However no males in the present study had a history of prostatis. (There was no information on 4 patients.)

3. Clinical urinary tract infection in females results in chronic pyelonephritis as seen at autopsy less frequently than that in males. Although difficult to prove, it would appear that many cases of urinary tract infection in females seem in involve primarily the lower urinary tract and do not result in chronic pyelonephritis. This explanation is

reasonable and may account in part for the data obtained.

4. Although the pathologic changes called chronic pyelonephritis may be the result of infection, they may also result from other types of disease where the sex ratio is closer to one to one, e.g., that associated with drugs (phenacetin (27)), hypertension (19, 36), congenital dysplasia (26).

5. In a further attempt to explain the discrepancy between the ten to one ratio of females to males clinically and the one to one ratio at autopsy, the clinical incidence of ten to one might be questioned for as noted earlier, there are very few clinical studies on urinary tract infection in the absence of obstruction. Of note are Raaschou's (32) study on 31 patients, 14 of which were in the absence of obstruction, and the recent study at the Grace New Haven Community Hospital described previously. Both of these studies were carried out on medical services. The incidence of urinary tract infection in the absence of obstruction was found to be from 10-13 females to one male in both studies. It seems possible that some cases with this disease were missed because they were treated on the urology service. If this were so the clinical ratio of females to males might be altered. However it is not considered likely that the number of cases that could have been missed in these studies would be sufficient to alter the ratio of females to males

from ten to one to one to one, especially since it is felt that clinical urinary tract infection in the absence of obstruction as seen on the urology service is much more common in women (12). Further in support of the clinical difference of the two sexes is the difference in incidence of a past history of urinary tract infection in the males and females with chronic pyelonephritis in the absence of obstruction (see Table 4) where 0% of the men and 32.2% of the women had a past history of urinary tract infection.

Thus 5 possibilities have been discussed in an attempt to explain the marked difference of the ratio of males to females with chronic pyelonephritis in the absence of obstruction clinically and pathologically. Two of these seem reasonable in the light of present knowledge.

a) The frequently seen clinical urinary tract infection in women does not invariably result in chronic pyelonephritis as seen at autopsy.

b) The changes which we are calling pyelonephritis at autopsy are actually being produced by agents other than infection, such as phenacetin, hypertension, or congenital dysplasia; and that these are appearing more frequently in the kidneys of men at autopsy, thus giving us a false impression of the frequency of the disease we call chronic pyelonephritis.

It is concluded that there is no thesis at the present

time which satisfactorily explains the discrepancy between the incidence of clinical urinary tract infection and pyelonephritis at autopsy. It will remain for prospective investigations fitted with proper controls to solve the many unanswered questions which have been raised by the present study.

SUMMARY AND CONCLUSIONS

Chronic pyelonephritis in the absence of obstructive disease of the urinary tract was found in 53 instances upon reviewing the autopsy material from January, 1957 to January, 1959 at the Grace New Haven Community Hospital. There was an equal distribution of these cases between the sexes (47% were males and 53% females). Kidneys with scars not specifically called pyelonephritic demonstrated a similar one to one sex distribution.

A review of this histologic material without prior knowledge of the pathologic diagnosis or the sex for both the chronic pyelonephritic and scarred kidney groups did not disclose any particular histologic features characteristic of one or the other sex. Neither was there any particular age distribution for one sex or the other. Similarly, there was no difference between the sexes in incidence of hypertension, family history of hypertensive vascular disease, or extent of renal damage as measured by elevation of N.P.N. The major difference between the sexes was the lower frequency with which a past history of urinary tract infection was elicited from the males as compared to the females.

The incidence of clinical urinary tract infection in the absence of obstruction was approximately ten to one in favor of the females. An attempt has been made to explain

the discrepancy between the sex incidence of clinical urinary tract infection and the sex incidence of chronic pyelonephritis at autopsy.

APPENDIX

Footnotes for Tables 2, 3, 4, 6, 7, 8

a. P.H. ↑BP — Past history of hypertension obtained from the clinical record, or a diastolic pressure of 100 mm. Hg. or higher in the past.

b. B.P. — Blood Pressure. This refers to the blood pressure obtained on the patient's last admission to the hospital. (Space blank when record of blood pressure on last admission not obtained.)

c. Fam. Hist. ↑BP Heart CVA — Family history of hypertension, heart disease or cerebrovascular disease. This refers to the history of one or more of these diseases in the patient's parents or siblings.

d. N.P.N. — N.P.N. in mg. %. This data was obtained by taking the highest N.P.N. on the last admission. If no N.P.N. was determined on the last admission, the highest N.P.N. of the most recent hospital admission prior to the last was recorded.

e. P.H. U.T.I. — Past history of urinary tract infection. This refers to the finding of the diagnosis of pyelonephritis (acute or chronic), "urinary tract infection," or cystitis, in the clinical record.

f. Urine Cult. — pos. = positive and ng = no growth or negative. Urine culture - many of these were not evaluated quantitatively - see Method. This data was taken from the clinical record. The most recent results were recorded. In only 1 case was there a change from positive to negative and since the positive was not evaluated quantitatively, it is felt that the negative is more valid. This is recorded as neg.

APPENDIX
(continued)

g. Diab. — Diabetes. Data obtained from clinical record of this diagnosis at any time prior to death.

h. Kid Wt. — Kidney weight. The weight of the left kidney is expressed over the weight of the right kidney. These weights were obtained at autopsy and are in grams.

i. Micro — Microscopic classification of the kidney. (See Method).

NS = Nonspecific scar
MFP = Minimal focal pyelonephritis
TFP = Typical focal pyelonephritis
DEK = Diffuse endstage kidney, pyelonephritis-like.
Pye = Pyelitis
No. = No abnormal tissue

* — This refers to a kidney weighing more than 100 grams but being described as "small" in the pathological protocol.

X — This refers to the presence of whatever factor it is listed under.

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